FOCUS REVIEW

Teaching technical skills using medical simulation: a new frontier

Kevin Lachapelle

As a medical student, I remember clearly the first time a surgeon gave me a needle driver and forceps and asked me to "sew" the fasciae of an abdominal incision. The closure was clumsy, tentative, and being left-handed, I could not easily open the driver which is designed for a right-handed person. The surgeon summarily removed the instruments from my hand and commented that it was good I wanted to be a surgeon because I could use the training! He said I needed to practice. This proved to be somewhat of a problem since I could not improve without being allowed to stumble through some portion of an operation.

Medical education and certainly the teaching of technical skills have essentially not evolved over the last 100 years. In the same period, our medical profession has exploded in terms of knowledge of disease, diagnostic tools, pharmacotherapy, and therapeutic interventions. However, we continue to teach clinical medicine through the apprenticeship model of "see one, do one, teach one". The way in which we learn is through the sheer volume of clinical exposure and practice on real patients.

The present health care system, with its emphasis on efficiency, time management, patient satisfaction, and outcome measures while delivering increasingly complex multidisciplinary care, can no longer rely solely on this model of clinical training. With further reduction in operating time, the "see one, do one, teach one" approach will no longer "cut it" for technical training. The problem is even more acute among junior house staff and medical students as they are seldom asked, allowed, or even required to perform technical skills during their training.

Teaching technical skills and interventions outside of the operating room using models and simulators specially intended for basic technical skills, may better prepare trainees for a positive and enriching educational experience in the technical or interventional platform. The recent advent of medical simulation centres such as the McGill Medical Simulation Centre is an attempt to improve the skills of all healthcare providers within a "patient safe" environment. The transfer of these newly acquired skills to the clinical arena is the ultimate goal. Osler brought the students to the bedside to learn first-hand from the patients. Simulation furthers this Oslerian doctrine by bringing the learner to the patient prepared, able, and engaged for the encounter.

The development of motor skills and the acquisition of technical skills are thought to occur in three stages according to Fitts and Posner. In the first stage (cognitive), the learner tries to understand and conceptualize the procedure (indications, contraindications, tools needed) and the mechanics of a technical skill and the steps involved. In the second stage (integrative), the learner translates the knowledge of the steps into action. Movements are clumsy and successes sporadic. In the third stage (autonomous), the learner, through practice, is able to perform in a competent manner the specific skill or procedure. The insertion of a central jugular line, which is taught at the Simulation Centre, highlights well how these three stages of learning frame teaching at the Centre. First, the learner must have knowledge about the procedure, the tools used, the appropriate anatomy, and an idea of the steps. A video is helpful. This preparatory phase is crucial and is known to accelerate learning. Second, the learner will actually use similar hospital equipment and attempt multiple times line placement on special task trainers using the same sterile technique used in the hospital setting. Feedback from instructors and peers is coupled with self-reflection. Appropriate feedback is the key to learning the right steps to avoid negative training. Third, (ideally) the learner schedules regular practice time on task trainers until the insertion is performed to a level of proficiency as determined by a panel of experts. The learner, armed with a basic level of competency and some confidence, performs a jugular line insertion on a real patient, while the bulk of the problems and difficulties with this procedure where dealt with in the simulation centre. There are a number of potential advantages to this type of training. The learner can focus on more important issues in the care of the patient. The patient is treated by a competent individual and suffers fewer complications. The hospital may save money by an overall reduction in central line infection. A whole list of technical skills, especially basic ones, such as knot-tying, suturing, chest tube insertion, biopsy, etc, can be taught using this staged approach to learning, which can be done outside the clinical arena. Unfortunately, none of theoretical advantages have been proven.

Similarly, more complex procedures and ones that involve many steps such as laparoscopic cholecystectomy may be taught and learned by breaking down the whole procedure into its component parts or individual skill set. In order to perform a laparoscopic cholecystectomy, the learner must be able to insert instruments safely into the abdomen, obtain a 3-D perception from a 2-D image, grasp, move, cut tissue, and clip the appropriate arteries and ducts. Each of these component tasks needs mastery, and all potentially can be accomplished outside the operating room using basic models. As a further help, one can bring all the components together: laparoscopic simulators mimic, albeit at a reduced level of realism, the whole procedure. It is theoretically possible to perform your first procedure without ever having “practiced” on a patient. There are 29 randomized trials comparing traditional technical training to simulation-based training. Although these studies are plagued by low number of participants and difficulty in measuring appropriate outcomes, some have demonstrated the value of simulation. In a study of laparoscopic cholecystectomy among junior residents, those trained using simulators completed the procedure 30% faster and made 6 times fewer errors than those trained using traditional methods. Many more studies are needed which help guide teaching of simulation and the impact it will will have on learning and eventually, patient outcome.

One area of growing interest and research in simulation and skill acquisition is how to tell if the learner, after all this training, is now competent to treat patients? Until now, we have relied on our own gestalt as teachers by essentially observing learners working in a clinical environment. In the assessment of a particular skill, it is crucially important to know what to measure and ensure that the measure is valid and reliable. The identification of the important metrics is not easy. The time to completion of a task is frequently used and certainly an experienced operator will be faster than a novice, but when is it that speed is less of a factor? In the jugular line example, a speedy operator may finish the procedure quickly but this speed should not come at the expense of a complication such as a tension pneumothorax. In general, experts decide which measures are important and then rigorously test them on novices, competent operators, and experts. This will be laborious as each skill must be dissected, understood, and tagged with appropriate valid and reliable performance criteria. Dr Fried’s group at McGill has been able to demonstrate through the MISTELS (McGill Inanimate System for Training and Evaluation of Laparoscopic Skills) program that simulation can appropriately assess laparoscopic skills. Using this paradigm, courses are given worldwide using these criteria of performance developed locally. The Toronto group use OSATS (Objective Structured Assessment of Technical Skills) in which the learner performs a standardized technical task under the observation of an expert.

The Fitts and Posner construct of motor skill acquisition may be well suited to developing competency using simulation training but will probably not lead to expertise. There is a difference in skill level required to place a jugular line in a thin, cooperative, stable patient who can lie in the Trendelenburg position versus a patient who is in full cardiac arrest and is having chest compressions. Ericsson has suggested that the difference between the competent individual and the expert is the amount of time devoted to deliberate practice. The term “deliberate practice” refers to highly focused training on defined tasks in which there is coaching or feedback and self-reflection. In comparing the average piano player and the concert pianist, the major difference is the amount of hours devoted to focused practice. The expert is born through tailored training and hours of repetition. However, the expert interventionalist is not only a technician. The patient–doctor interface is always in the forefront and, with increasingly complex patients and procedures, the treating physician must be an expert communicator, team player, and be able to decide the best treatment option for any individual patient from a number of different decision trees. Expert judgment becomes as important as expert technical ability in treating patients. The learner needs to acquire all to become an expert; knowledge, skill, and judgment. There is new interest in understanding how one gains judgment, and whether it can be taught.

While adapting these concepts to simulation-based medical education, it is apparent that the best way to use this tool is to integrate it within a well-designed training curriculum, with simulation sessions that are learner and task specific. A layered approach to simulation with increasing complex situations over a course of training will complement the clinical exposure. For example, the first simulation-based training for jugular line insertion would be simply procedural; perform the line insertion on the inanimate task trainer. The second would be on a high fidelity mannequin which can react physiologically and unexpectedly to the procedure, mimicking real complications, a more involved situation where one must recognize the complication and treat it accordingly. The third would integrate performing the procedure on a high fidelity mannequin in the context of a multiple injury trauma victim attended to by a whole team of doctors, nurses, and therapists. This is a life-like situation where communication, prioritization, decision-making, teamwork, and technical skill all come to bear on the successful jugular line insertion and patient outcome. This type of training can also be applied to the maintenance of skills of professionals and to those all ready in practice who wish to learn new techniques and procedures.

Simulation is new to healthcare, and unlike aviation, we are just starting to learn how to use it. We are not yet experts in this new field. Through experience and research, we will understand how to best implement this important tool. It is safe to say that a new generation of doctors will be trained using simulation–based education and that a whole new group of medical educators will be born.

Dr. Kevin Lachapelle, MD MSc FRCSC, is an Associate Professor of Surgery at McGill Univsertiy, a Cardiothoracic Surgeon of the McGill University Health Centre, Director of the McGill Medical Simulation Centre and Director of the McGill University Cardiac Surgery Training Program